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p. 4

THE CALIFORNIA CORRIDOR TRANSPORTATION SYSTEM: A DESIGN SUMMARY

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INTRODUCTION

The systems approach to engineering design demands that any factor that may have some bearing on the project be identified, evaluated, and allowed to influence the design. The extent of this influence needs to be determined through a logical analysis of all competing factors. To this end a design group was assembled to find and research criteria relevant to the design of a California Corridor Transportation System. The efforts of this group included defining the problem, conducting a market analysis, formulation of a demand model, identification and evaluation of design drivers, and the systematic development of a solution. The results are summarized in the following pages.

The California Corridor contains a complex, expanding system of transportation, with requirements set by a wide variety of system users. The corridor is defined as a region where significant demand for transportation exists, along a line between major cities. This definition incorporates transportation demands both within and surrounding these cities. For the purposes of this study, California was selected, because of its intrinsic, generic qualities, and four of its major cities, Sacramento, San Francisco, Los Angeles, and San Diego, for the axis. The users are loosely categorized under the headings of commuters, transients, miscellaneous travelers, and freight, while the types of trips they take are categorized as capillary trips, intra-corridor, and inter-corridor.

The problems of the current system were analyzed and used to determine "design drivers," which were divided into the broad categories of cost, convenience, feasibility, environment, safety, and social impact. The relative importance of individual problems was addressed, resulting in a "hierarchy" of design drivers. Where possible, methods of evaluating the relative merit of proposed systems with respect to each driver were developed.

THE SYSTEM

The system envisioned by the design team is brought about through a controlled evolution of the present day system.

Beginning in the near future, a measured series of changes are proposed that will offer consistent improvements in the areas of each design driver, eventually bringing to the corridor in the year 2020 a transportation system that better serves the interests of the citizen.

This gradual evolution begins in the year 1995, with a ground transportation network of highly efficient jitneys and buses, offering near door-to-door service on a scheduled basis for metropolitan commuters. Both these vehicles are refined versions of existing technology, using clean-burning, compressed natural gas for fuel, and following closed routes through neighborhoods and along reserved highway lanes. They interact with each other and with other forms of transportation through specially designed modeports, strategically located near the intersections of major freeways, in order to reduce the time and inconvenience of transferring from one vehicle to another.

Longer distance travelers are accommodated by a new aircraft, the QSTOL, which stands for Quiet, Short-Takeoff-and-Landing. The QSTOL carries 100 passengers, and is configured with 3 lifting surfaces and counterrotating propfans. It is specifically designed to minimize environmental impact, offering improvements in its noise signature and pollution levels, as well as enhanced abilities to serve smaller, more numerous airports. By utilizing these, air traffic congestion will be diffused over wider regions, providing larger margins of safety without raising community noise levels or building new airports.

Ten years later, in 2005, significant advances are made with the introduction of two innovative new public transportation modes. The first is a group of giant, hybrid aircraft, called CCATs for Corridor Combined Aircraft Transit System. These semi-buoyant helipsoids are turboprop-driven lifting bodies, reminiscent of airships and capable of carrying 600 passengers in luxury, comfort, and safety. These aircraft will fly closed routes, like great, airborne buses, over major cities and along the length of the corridor. Immense savings in time and cost are gained through the procedure of maintaining the aircraft in constant flight, boarding passengers and freight with tiltrotor shuttles that ferry between a boarding port on the upper surface of the aircraft and conveniently located ground stations. The ability of this fleet to transport vast numbers of people will be essential to meet the large increases in demand anticipated in the foreseeable future.

The Personal Rapid Transit (PRT), will introduce a quick, convenient, and cost effective method for everyday travelers to get around in congested downtown areas, where the jitney's effectiveness is reduced by the same congestion that makes automobiles so inefficient. PRTs are four-passenger, automated, electric rail coaches that travel along elevated monorails at speeds up to 40 mph. They offer the privacy and convenience of automobiles, high average speeds in congested areas, minimal noise and pollution, freedom from parking headaches, and the luxury of travel time spent as leisure.

Five years after this, in 2010, the completion of two Corridor Access Ports (CAPs) are anticipated. Situated near the extremities of the corridor, the CAPs are gigantic, high-capacity airports, designed to eliminate congestion from the skies over larger cities by rerouting all transient and out-of-corridor traffic away from major metropolitan airports. They will be capable of expanding to meet the needs of the future without conflicting with the surrounding communities and will act as ports-of-entry for the entire southwest coast. The CAPs will be served by the QSTOL, the CCATS tiltrotor, long-distance conventional aircraft (CTOLs) going out of the corridor, and another new mode of mass transportation, the magnetically levitated train.

Expected to become fully operational at the same time as the CAPs, the mag-lev trains will carry 250 passengers at an average speed of 230 mph. They will follow a route along the inland valleys of the corridor that leads from the Los Angeles basin to the Bay Area. Fast, quiet, and clean, the mag-lev train is designed to offer a groundbased alternative to the CCAT and the QSTOL.

The final step in the implementation of the system is in 2020, when the Chicken Air Taxi service is expected to become fully operational. Beginning with a design philosophy of "a chicken in every pot, and a tiltrotor in every garage," (hence the name) the original concept was intended to eclipse the automobile in its level of personal service and independence. The design eventually evolved, through a series of compromises with the design drivers, into a single seat, fully automated, electric helicopter taxi that will take the discriminating traveler where he wants to go, when he wants to go there. Operating under the constant surveillance of an omnipotent air traffic control system based on the interaction between satellites and computers, the Chickens will operate between literally thousands of destinations throughout metropolitan areas.

Thus, over a period of 25 years, the corridor transportation system is seen to evolve from its present state of inefficiency and congestion to one of vastly improved service, satisfying the needs of travelers of all income levels, and covering a wide spectrum of destinations. The expense of implementing the system is rendered inconsequential when one compares the benefits of the invigorated economy this system will help to promote, to the losses, waste, and damage California will endure, should we choose to remain idle. Among the anticipated benefits are significant improvements in the quality of life and the environment, as well as increased personal liberty.

CONCLUSION

The approach taken in designing the California Transportation System is concerned with the needs of California. The solution addresses the demand for all levels of transportation, within, between, and out of major metropolitan areas. The solution deals with both the present demands and those anticipated in the future. It is an approach concerned with the "total picture" of transportation, and as such, it is a model for other transportation studies both in other regions and in the future.

Transportation is a dynamic enterprise, and must be assessed on a continuous, systemwide basis. It is emphasized that studies of transportation system integration, impact, and evolution must be continued, and that the resulting solutions be designed and implemented in a macroscopic fashion. Only by applying a systems approach to transportation engineering can problems be solved without creating others.

ADDITIONAL PROJECTS

Phoenix

As a senior design project, the Hybrid Tandem Fan team was required to design a low-cost, export, short-takeoff, vertical-landing (STOVL) supersonic fighter. The specifications used were acquired from the 1989/1990 AIAA/General Dynamics Corporation Team Aircraft Design Competition's request for proposal. The Phoenix (Fig. 1) is our team's design answer to this proposal.

The propulsion system we have selected is the Hybrid Tandem Fan (HTF). The HTF is similar to conventional turbofan jet engines, but includes two separate compression fans. There are two modes in which the engine can operate; parallel and series. Parallel mode is used for takeoff, landing, and subsonic cruise. Series mode, which provides about 20% more thrust, is used for acceleration, supersonic flight and high-*g* maneuvers. The side and rear nozzles are all vectorable for vertical flight and combat maneuvers. The side and rear nozzles are all vectorable for vertical flight and combat maneuvers. The Phoenix can cruise at a maximum speed of Mach 1.5. It has a statically stable flight control system for lower cost and ease of maintainability.

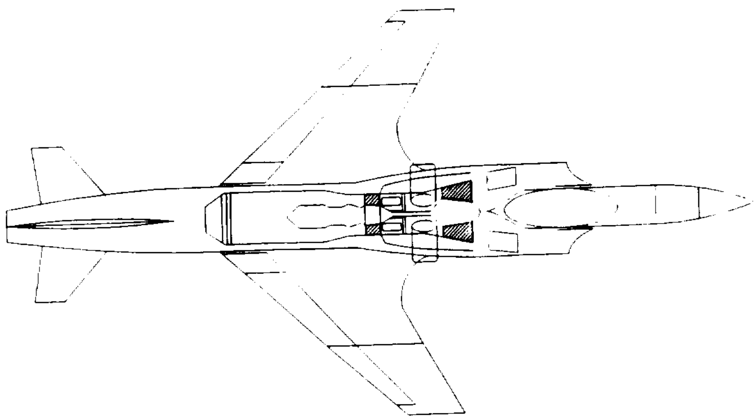
In our preliminary design, we are using conventional vertical and horizontal tails and a forward swept wing. We chose a forward swept wing (FSW) configuration because of its better performance in the transonic flight regime, higher lift coefficient, more effective ailerons, since a FSW stalls at the roots first, and reduced suckdown during vertical landing. However, there is a weight penalty with a forward swept wing due to structural divergence. The use of composites will help to lower the weight.

The Phoenix answers the need for a low cost, highly maneuverable, and extremely versatile airplane for export to less economically and technically advanced countries.

ASTOVL - Vectored Thrust Concept

The Ariel, a low cost, Advanced Short-Takeoff-Vertical landing (ASTOVL) supersonic fighter, is a proposal for the 1989/1990 AIAA/General Dynamics Corporation Team Aircraft Design Competition. The Ariel incorporates an advanced turbofan engine with three full-vectoring nozzles, two fore, with plenum-chamber burning, and one aft, to achieve the vertical thrust used in take-off/landing and increased maneuverability in combat. The intent of this design is to provide a low-cost, high-performance aircraft for export to countries without the means to build their own, and yet retain sufficient range, maneuverability, and weapons payload to be competitive in today's combat arena.

Figure 2 shows a three-view representation of the Ariel and provides some of its important geometric parameters. The maximum range, which compensates for ascent to and descent



	WING	VERTICAL TAIL	HORIZONTAL TAIL
Area (sq ft)	277 8	81	56 5
Span (ft)	31 2	9	12
MGC (ft)	9 6	9 9	4 69
Aspect Ratio	3 53	1 0	2 55
LE Sweep (deg)	-30	48 2	42
Taper Ratio	35	293	369
Root Chord (ft)	13 2	13 92	6 4
Tip Chord (ft)	4 62	4 08	2 4
Thickness Ratio	.05	.04	04
Dihedral (deg)	-2 35	90	-8
Incidence (deg)	1 5	0	variable
Airfoil	(see sec 5 2)	0004	0004

Aileron Chord Ratio: 0.3c
Aileron Span Ratio: 0.63 - 0 95c
Flap Chord Ratio: 0.3c

Rudder Chord Ratio: 0 3c
Rudder Span Ratio: 0 1 - 0.7c
Flap Span Ratio: 0 17 - 0.62c

	Fuselage	Cockpit	Overall
Length (ft)	60	9	60
Maximum Height (ft)	10.8	11 5	20.2
Maximum Width (ft)	6.4	3	31 2

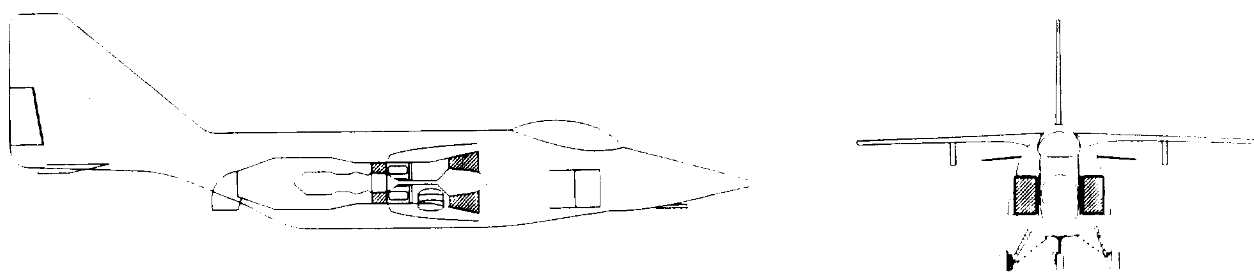
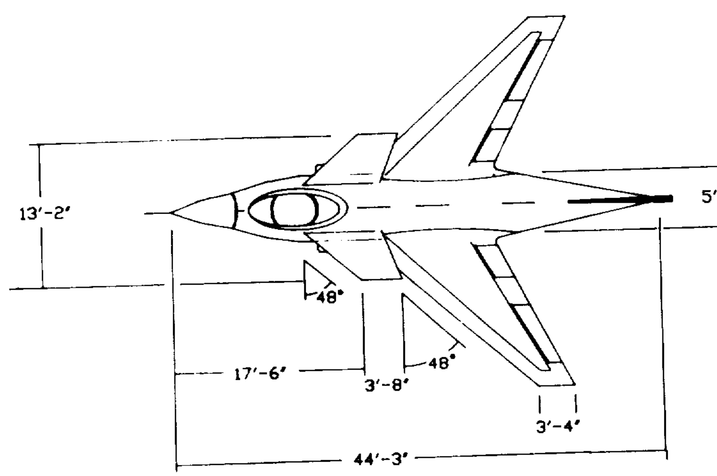


Fig. 1. The Phoenix

length	44.33 ft
span (wings deployed)	35.06 ft
span (wings stored)	20.50 ft
height (wings deployed)	13.77 ft
height (wings stored)	13.77 ft
takeoff weight (mission 1)	21,900 lbs
empty weight	14,592 lbs
inlet area (total)	10 ft^2



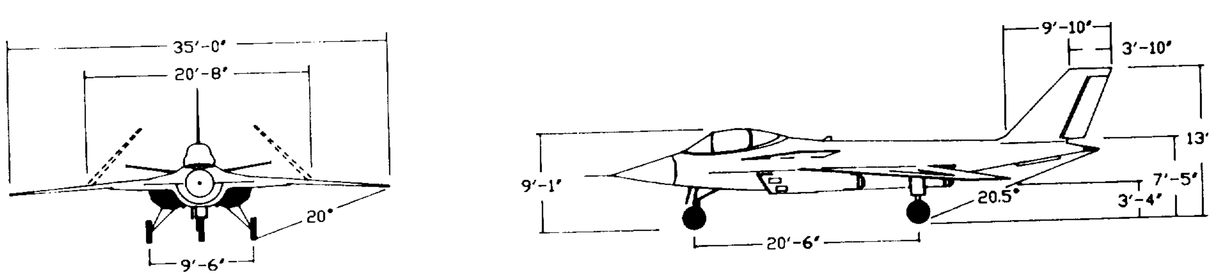


Fig. 2. Ariel

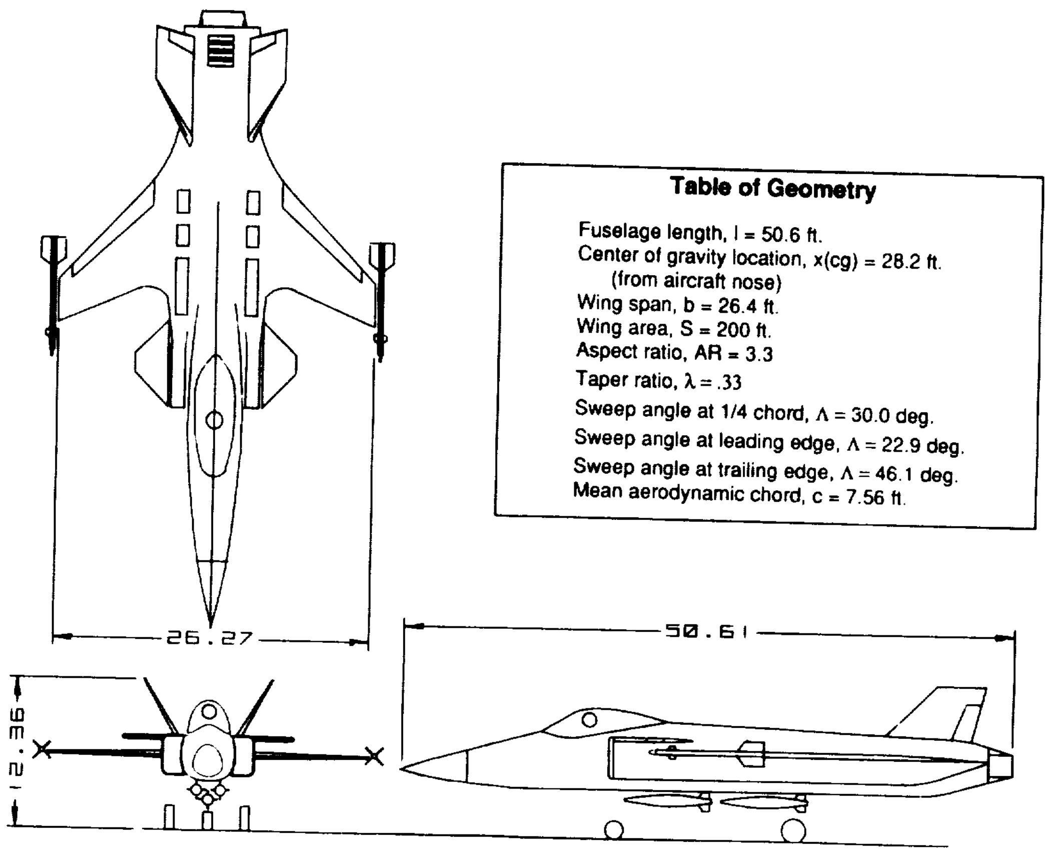


Fig. 3. Sea Hawk

from the best cruise altitude of 40,000 ft and best cruise Mach is 0.89. The Ariel was designed to take off in less than 300 feet and to land vertically; however, with a thrust to weight ratio of 1.26, a vertical takeoff is possible if necessary. The maximum shift in c.g. location during the Air-Ground mission is 1.2" which is only a 1.1% change in static stability, and during the Air Superiority mission the shift is 1.9", a static change 1.7%. These small changes in the static margin will not noticeably affect handling qualities throughout the range of flight.

The Ariel is designed to be a low-cost, high-performance military fighter. At under 15 million 1990 dollars, the Ariel is in the optimum price range for third world countries' military needs. At the same time, the Ariel has the capability to perform high-speed Air Superiority and Air-Ground missions. It can also sustain speeds of Mach 1.5 in both cruise and constant altitude turn. Another major advantage of Ariel is its STOVL capability. The Ariel has the ability to hover and land vertically, thereby reducing the amount of landing area required by the airplane.

Ejector Concept Design: "Sea Hawk"

The Sea Hawk is a low cost, export, supersonic short-takeoff and vertical-landing (STOVL) jet fighter (Fig. 3). The design was based on the AIAA Team Aircraft Design competition request for proposal.

The Sea Hawk is powered by an advanced concept turbofan engine similar to the Pratt and Whitney F100-220 turbofan. This provides a static sealevel thrust of 24,000 lbs giving the Sea Hawk a thrust loading at takeoff of 1.2. Vertical thrust is attained through the use of an ejector vertical thrust system similar to that on the E-7 experimental aircraft. The ejector system consists of a primary jet shrouded by a diffuser duct. The primary flow entrains a secondary flow which increases the mass flow rate through the diffuser and hence, increases the thrust of the ejector. Forward swept wings were utilized to decrease transonic and supersonic drag, provide sufficient stability, and give the agility needed for a fighter aircraft. The wings are strengthened by the use of composites and titanium. Agility is also improved through the use of a 2-D vectorable nozzle and through the use of forward canards, which are also used for trim. Twin, canted vertical tails are used for lateral-directional control. A reverse thruster and a reaction control system are used to aid maneuverability in the hover mode. These components combine to create a new advanced STOVL fighter at a low cost of approximately 16 million 1989 US dollars.